Wind Power for Remote Alaskan Villages

by Gerry Nix 12/99

Background

There are hundreds of remote villages in Alaska, usually located far from any existing electricity transmission lines tying back to central generation plants. This requires that these villages have their own electricity generating systems, usually employing diesel engine-driven generators and occasionally hydroelectric generation. Usually, fossil fuels other than diesel are unavailable. The resulting electricity tends to be costly, usually because of the transportation costs associated with the diesel fuel. In addition, there are numerous potential environmental hazards from the transportation and storage of diesel fuel.

Scope

There are at least 80 remote villages in northern and western Alaska that are thought to have sufficient wind to make wind turbines viable for production of electricity. The current costs for electricity from diesel- powered generation ranges from about 15¢/ kilowatt-hour (kWh) to greater than 50¢/kWh, even with very significant subsidy from the state government. These villages are typically the homes of indigenous peoples, such as the Eskimo, who have a relatively low income and practice subsistence living. Many of these villages store diesel fuel in aging, single-wall tanks that are beginning to leak.

What Is Required to Establish Wind Energy in Alaska?

Wind-generated electricity must compete on an economic basis with diesel-generated electricity for wind to be viable. Other requirements are that the hybrid system is robust, easily repairable, and that the contingency operation always be pure diesel- powered generation. In addition, wind energy must be validated through test projects. These projects not only provide the necessary experience to familiarize users with wind turbines, but also provide the data on costs of installation and operation and maintenance needed to perform proper economic assessments.

Current Projects

DOE has funded several projects in Alaska with different objectives.

Kotzebue, Alaska—the First Major Alaskan Wind Power Plant. DOE, in partnership with the Kotzebue Electric Association (KEA), and the State of Alaska, has funded a wind power plant that is hybridized with a large and very well run diesel generation plant at Kotzebue. Kotzebue, located in northwest Alaska about 30 miles north of the Arctic Circle, has a population of about 3000 people, mostly Inupiat Eskimo. The diesel power plant has a 11.2-megawatt (MW) capacity, with six engine generators. The average load is about 2.6 MW, low load about 1.6 MW, and peak load about 3.6 MW.

There are currently 10 Atlantic Orient Corporation (AOC) 15/50 wind turbines installed at Kotzebue, with a wind generation capacity of about 660 kW. The state and KEA provided the first three turbines, which have operated since 1997. The U.S. Department of Energy /National Renewable Energy Laboratory (DOE/NREL), KEA, and the State provided funding for the next three and DOE has provided funding for the rest of the turbines. Turbine operation has proven to be reliable within the Arctic environment, and experience has shown how to install the turbines in permafrost. The economics for electricity generated with wind turbines is comparable to that generated with diesel generators, and KEA is confident that future turbine installations will result in lower- cost wind- generated electricity than that from the diesel generators. This project has provided considerable data on costs; installation, operation and maintenance requirements, and techniques; and has built confidence in the robustness and viability of wind power in Alaska.

Although the KEA hybrid system is low penetration, with a maximum of about 30 percent of electricity generated at any time, KEA intends

to install as much as 2 MW of wind generation capacity, which will require a sophisticated control system to provide optimum generator source dispatching and minimum electricity costs. KEA has been a strong supporter of wind energy deployment in Alaska and sees construction, operation, and maintenance of wind-diesel power plants as a potential business opportunity.

Wales, Alaska—A High-Penetration Prototype With Storage. DOE/NREL, EPA, KEA, the State of Alaska, and AVEC (Alaska Village Electric Cooperative) have sponsored a project to add 2 AOC 15/50 wind turbines to the diesel power plant, which serves a village of about 150 Eskimos in western-most Alaska. The average load is about 60 kW. The Wales project is designed as a high-penetration system, with the bulk (~60 percent) of the electricity to come from the wind turbines. This requires shutting off the diesels and running purely on wind whenever possible. This necessitates a sophisticated control system, a battery bank for switching between generators, and productive loads to use any excess electricity from the wind turbines as heat in the local school. NREL has developed the control system and the energy storage subsystem. This project is currently in the installation phase and should be operational during the summer of 2000.

St. Paul Island, Alaska—A High- Penetration Prototype without Storage. Northern Power System (NPS) of Waitsfield, Vermont, contracted with the local Native Corporation Tanadgusix to build and operate a wind- diesel hybrid power system to serve a specific area on the island, with no ties to the grid. This service includes powering the airport. NPS installed a Vestas 225-kW wind turbine and two 150- kW diesel generators, with excess wind-generated electricity used to heat buildings via a hydronic system. This system was started in mid-1999 and has worked very well. DOE/NREL has provided funds for documenting and monitoring the system.

Selawik, Alaska—A Low-Penetration Prototype. A project is currently in the planning stages for a low- penetration wind-diesel hybrid power system in Selawik, a village of about 750 Inupiat Eskimo with a 935- kW diesel power plant and a consumer cost of 17.4 ¢/kWh with state subsidy. The planned project will add about 198 kW of wind power with 3 AOC 15/50 turbines. The system will have a simple control system and will use productive loads. The project will be a collaborative effort between KEA, AVEC, the State of Alaska, and DOE. It should be operational in late 2000.

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